Electric Field and charges

TERMS & DEFINITIONS

Term	Definition
Electric charge (q)	A fundamental property of matter responsible for electric force.
Point charge	An electric charge concentrated at a single point in space.
Electrostatic force	The force between two stationary electric charges.
Coulomb's Law	The force between two point charges is directly proportional to the product of their charges and inversely proportional to the square of the distance between them.
Permittivity (ε)	A measure of how much resistance is encountered when forming an electric field in a medium.
Vacuum permittivity (ε_0)	The permittivity of free space or vacuum.
Unit vector ($\hat{r}$)	A vector of unit length indicating direction between charges.

SYMBOLS

Symbol	Meaning
q_1, q_2	Magnitudes of two point charges
r	Distance between the two point charges
$\vec{F}$	Electrostatic force vector
k	Coulomb's constant (in vacuum)
ϵ_0	Permittivity of free space (vacuum)
$\hat{r}_{21}$	Unit vector from charge 1 to charge 2

CONSTANTS

Constant	Symbol	Value	Unit
Coulomb's constant	k	9×10^9	$\mathrm{N\cdot m^2/C^2}$
Permittivity of vacuum	ε_0	8.854×10^{-12}	$\mathrm{C^2/N\cdot m^2}$
Elementary charge	e	1.602×10^{-19}	Coulombs (C)

FORMULAS

1. Coulomb's Law (Scalar Form)

$$F = k\frac{q_1 q_2}{r^2}$$

Where:

- F: Magnitude of force
- q_1, q_2: Charges
- r: Distance between charges
- $k = \frac{1}{4\pi\varepsilon_0}$

2. Coulomb's Law (Vector Form)

$$\vec{F}_{21} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2} \hat{r}_{21}$$

- $\vec{F}_{21}$: Force on charge 2 due to charge 1

3. Relation Between k and ε_0

$$k = \frac{1}{4\pi\varepsilon_0}$$

4. Superposition Principle (Total Force)

$$\vec{F}_{\text{total}} = \sum_{i=1}^{n} \vec{F}_i = \frac{1}{4\pi\varepsilon_0} \sum_{i=1}^{n} \frac{q q_i}{r_i^2} \hat{r}_i$$
